

Group _____

_____, _____, _____
names**The Fate of the Earth**

Recall a) the geometric argument that since the surface area of the Earth is $4\pi R^2$, but it intercepts sunlight as though it were a disk, i.e. it casts a circular shadow with area πR^2 . The average flux of solar heat reaching the Earth is the solar constant times the ratio of the area of the spherical planet to its circular cross section, which is _____.

Further recall b) that the present value of the solar constant is 1366 W m^{-2} , and c) that the Earth's albedo is 30%. What is the average rate of solar heating, or insolation? _____ W m^{-2} , taking into account reflection and the geometric factor described above.

Now solve the Stefan-Boltzman Law $E^* = \sigma T^4$, for total thermal blackbody radiation in W m^{-2} , where $\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$, to find the Earth's blackbody equilibrium temperature, i.e. the temperature where the radiated IR radiation is equal to the absorbed shortwave radiation you just calculated _____. Hint: an easy way to take 4th roots is to take the square root of the square root. It is also easier to separate out the 10^{-8} and divide by its fourth root (ie $10^{-2} = 0.01$) as another factor.

What is the difference between this temperature and the average surface temperature of the Earth?

At what altitude in the standard atmosphere is the actual temperature equal to the blackbody temperature? _____

For the following, assume that the lapse rate and altitude where the actual temperature is equal to the blackbody temperature stay fixed. This assumption is equivalent to assuming that the difference between the blackbody temperature and the surface temperature is 32-33°C.

Astrophysicists tell us that the sun is slowly increasing its luminosity as it converts Hydrogen to Helium. The table at the right gives predicted values of the solar constant at intervals of 1 Byr in the future. Choose the time corresponding to your group letter.

Group	Time (Byr)	Esol (W m^{-2})
A	1	1503
B	2	1654
C	3	1821
D	4	2004
E	5	2205
F	6	2428

Calculate the blackbody equilibrium temperature for that time _____

Under the assumptions outlined at the top of the page, what will the Earth's surface temperature be? _____

Do you think that life will still exist on Earth at your time? _____.

The fate of the planet depends on *you*.